Next-Generation Laser-Based Natural Gas Leak Detection

James J. Scherer, Ph.D., CEO
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Contact: james.scherer@aerissensors.com
MIRA: Worlds smallest ultrasensitive laser-based gas sensor platform

- **Laser Absorption** Spectroscopy provides sensitive, accurate measurements
- **1ppb/s** sensitivity
- 10x smaller, lighter instruments (MIRA Pico shown below)
- Mid-IR operation accesses more species

**Unique, Patent Pending** multipass cell

- Robust, state-of-the-art monolithic design requires no alignment or regular servicing

**Proprietary Custom Electronics, Software**

- 50 years tribal knowledge in a cc sized board

**5-20x Lower** power consumption and 2-10x lower cost than competing products
Core Technology: Mid-IR laser absorption spectroscopy

- **Direct absorption** is measured as the laser wavelength is rapidly tuned

- Simple, general, robust and proven approach

- Middle infrared = much stronger absorption
  - 200x for CH$_4$, 8,000x CO$_2$, 32,000x for N$_2$O

- Discrete, unique “fingerprints” in the MIR eliminate cross sensitivity

- **Only optical sensor with simultaneous ethane and methane at 1ppb/s!**
**Make Natural Gas Green Again!**

- Natural gas has largely replaced reductions in coal over last 20 years

- CH$_4$ 80x more potent than CO$_2$ in 20 yrs
  - Each 1.25% that leaks *doubles the carbon footprint*
  - Estimates are that leaks are between 1.5-8%, making NG worse than coal!

- Aeris measures CH$_4$, H$_2$O, and C$_2$H$_6$
  - C$_2$H$_6$ (2-10% of NG) : discrimination of thermo- vs biogenic sources

- Many Potential Embodiments
  - *In-situ autonomous, mobile, handheld, airborne/UAV*
Natural Gas Leak Detection: Applications

- Fixed, autonomous monitoring
  - *Wellpads*: (1,000,000+ wells)
  - *Compressor stations*
    (1500 turbine + 10,000’s recip)
  - *Storage facilities*: e.g. Aliso Canyon

- Handheld
  - 1000x more sensitive than NDIR, no consumables
  - Worlds only trace handheld simultaneous ethane/methane

- Mobile: Pipeline, Utilities
  - GPS data combined with sensor data provides leak MAPS

- Airborne: UAV, conv. aircraft
  - Unique size/weight
• Ethane is typically 2-5% of the NG stream
• No Ethane in ambient air
• Ethane is not produced in biological systems
• Biogenic methane sources:
  • Permafrost, bogs, landfills, livestock, sewage plants
• Isotope approaches less accurate, more ambiguous
  • Isotope ratios for C, H (D), can overlap over wide range-
• If ethane and methane correlate, source is fossil fuel!
• Aeris has unmatched 1ppb ethane sensitivity! Enables accurate C₂H₆:CH₄
Simultaneous gas detection and GPS enables “maps” of leaks

CH4 only = **Green**, CH4+C2H6 = **Red** = leak!

Persistence of leaks on multiple passes indicates leaks vs passing motorcycles, etc.

Deployed in multiple service vehicles, a citywide map of leaks is obtained over a period of time.
• Elevated methane (green) w/o ethane rules out natural gas as source

• Biogenic sewer gas

• Eliminates false alarms and unnecessary “leak surveys”
• La Brea Tar Pits In West Los Angeles

• Presence of CH$_4$ + C$_2$H$_6$ at unique 1% level - Not Natural gas from utility!
Aeris MIRA Pico Mobile LDS: Ethane+Methane= NG Leak
2 dozen+ NG leaks detected in 2 hours with 99%+ confidence
Aeris Pico Mobile LDS vs. Competition:
Only 1 correlation detected (vs. 28 w/Aeris Pico Mobile LDS)
ARPA-E Project: “Autonomous, High Accuracy Natural Gas Leak Detection System”

- **Autonomous** determination of leak location and size at the wellpad:
  - New Aeris MIRA laser sensor
  - New, LANL developed neural-network analysis approach
- Initial Field tests at CSU support feasibility: leak location rapidly determined!
Aeris MIRA Leak Detection System: Summary

- Disruptive new, laser-based gas analyzer platform
  - 10-15x improvement over existing laser-based analyzers across critical metrics
  - Lower capital cost, lower total cost of ownership, unmatched C$_2$H$_6$ performance
  - Unique size/weight/power consumption enables new ways of thinking about leak detection

- New capabilities in fixed and mobile gas leak detection, wellpad monitoring
  - accurate maps of gas leaks “assembled” over time
  - urban and regional leaks in the distribution systems
  - Looking for interested Utility companies

  *Initial wellpad testing of ARPA-E prototype system indicate rapid, unmatched leak detection capability: 24/7/365 truly autonomous monitoring*